

## Helminth Records from Eleven Species of *Emoia* (Sauria: Scincidae) from Oceania<sup>1</sup>

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**Abstract:** As part of an ongoing study of the biogeography of helminth parasites of lizards from Oceania, 53 specimens of *Emoia* (11 species) were examined, as follows: *E. atrocostata*, *E. boettgeri*, *E. caerulocauda*, *E. cyanogaster*, *E. cyanura*, *E. impar*, *E. nigra*, *E. nigromarginata*, *E. ponapea*, *E. sanfordi*, *E. trossula*. One species of Digenea, *Paradistomoides gregarium*, and six species of Nematoda, *Hedruris hanleyae*, *Maxvacchonia chabaudi*, *Parapharyngodon maplestoni*, *Physalopteroides arnoensis*, *Spauligodon gehyrae*, and *Moaciria* sp. indet., were found. These helminths have been reported previously from other lizard species. Seventeen new host records and eight new locality records are reported.

AS PART OF AN ongoing investigation of the biogeography of helminth parasites of lizards in Oceania, we identified helminths from a collection of skinks (*Emoia* spp.) from Belau, Federated States of Micronesia, Fiji, Tonga, and Vanuatu. The genus *Emoia* consists of at least 72 species that range from Southeast Asia through the Indo-Australian Archipelago and Oceania (Brown 1991). To our knowledge, only *Emoia cyanura*, *E. nigra*, and *E. samoensis* have previously been reported to harbor helminths (Goldberg and Bursey 1991, Goldberg et al. 2000). The purpose of this paper is to add helminths from 11 species of *Emoia* to the checklist of endoparasites for lizards from Oceania and to ascertain their distribution on the islands of Oceania. The checklist of endoparasites for lizards from Oceania began with the summaries of helminthological data on geckonid and scincid lizards by Goldberg et al. (1998, 2000) and Goldberg and Bursey (2002).

### MATERIALS AND METHODS

Eleven species of *Emoia* ( $n = 53$ ) from Oceania were examined, as follows: *E. atrocostata* ( $n = 1$ , Kobasang Island, Belau,  $7^{\circ} 30' N$ ,  $134^{\circ} 30' E$ ); *E. boettgeri* ( $n = 1$ , Pohnpei Island, Federated States of Micronesia,  $9^{\circ} 0' N$ ,  $150^{\circ} 0' E$ ); *E. caerulocauda* ( $n = 8$ , Efate Island, Vanuatu,  $15^{\circ} 0' S$ ,  $168^{\circ} 0' E$ ); *E. cyanogaster* ( $n = 2$ , Efate Island, Vanuatu); *E. cyanura* ( $n = 9$ ; 4 from the Kingdom of Tonga,  $19^{\circ} 50' S$ ,  $174^{\circ} 30' W$ ; 1 from Pohnpei Island, Federated States of Micronesia; 4 from Nanuku Island, Fiji,  $16^{\circ} 35' S$ ,  $179^{\circ} 08' E$ ); *E. impar* ( $n = 5$ ; 4 from Efate Island, Vanuatu; 1 from Ugaga Island, Fiji,  $18^{\circ} 22' S$ ,  $178^{\circ} 13' E$ ); *E. nigra* ( $n = 11$ , Kingdom of Tonga); *E. nigromarginata* ( $n = 10$ , Efate Island, Vanuatu); *E. ponapea* ( $n = 1$ , Pohnpei Island, Federated States of Micronesia); *E. sanfordi* ( $n = 1$ , Efate Island, Vanuatu); *E. trossula* ( $n = 4$ , Kingdom of Tonga). Lizards from the Kingdom of Tonga were collected in 1972 and are deposited in the Museum of the South Pacific, Suva, Fiji. *Emoia atrocostata*, *E. boettgeri*, and *E. ponapea* were collected in 1991 and are deposited in the California Academy of Sciences, San Francisco. All other *Emoia* were collected in 1993 and are deposited in the United States National Museum, Washington, D.C.

Lizards were dissected shortly after capture; helminths were removed and placed in vials of 70% ethanol; the carcasses were then preserved in 10% formalin and subsequently

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stored in 70% ethanol. For lizards from the Kingdom of Tonga, the esophagus, stomach, and small and large intestines were opened and separately searched for helminths under a dissecting microscope. From the other localities, only stomachs were examined. The helminths were examined in 2001, at which time the nematodes were identified after clearing in a drop of glycerol under a cover-slip on a microscope slide, and the digenleans were stained with hematoxylin and studied as whole mounts.

#### RESULTS

We found one species of Digenea, *Paradistomoides gregarium* (Dicrocoeliidae), and six species of Nematoda: *Hedruris hanleyae* (Hedruridae), *Maxvachonia chabaudi* (Cosmocercidae), *Moaciria* sp. indet. (Heterakidae), *Parapharyngodon maplestoni* (Pharyngodondidae), *Physalopteroides arnoensis* (Physalopteridae), and *Spauligodon gehyrae* (Pharyngodontidae). Prevalence (percentage of host species infected by a helminth species) and mean intensity  $\pm 1$  SD (number of individuals of a helminth species divided by number of infected hosts) are given in Table 1. Voucher specimens of the helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland: *Emoia atrocostata* (*Paradistomoides gregarium*, USNPC 93732); *Emoia boettgeri* (*Hedruris hanleyae*, USNPC 93733; *Moaciria* sp. indet., USNPC 93734); *Emoia caeruleocauda* (*Hedruris hanleyae*, USNPC 93735); *Emoia cyanogaster* (*Hedruris hanleyae*, USNPC 93736); *Emoia cyanura* (*Hedruris hanleyae*, USNPC 93737); *Emoia impar* (*Hedruris hanleyae*, USNPC 93738, 93739); *Emoia nigra* (*Hedruris hanleyae*, USNPC 93709); *Maxvachonia chabaudi*, USNPC 93715; *Parapharyngodon maplestoni*, USNPC 93710; *Physalopteroides arnoensis*, USNPC 93712); *Emoia nigromarginata* (*Hedruris hanleyae*, USNPC 93740); *Emoia pona-pea* (*Moaciria* sp. indet., USNPC 93741); *Emoia sanfordi* (*Hedruris hanleyae*, USNPC 93742); *Emoia trossula* (*Hedruris hanleyae*, USNPC 93727); *Physalopteroides arnoensis*, USNPC 93731; *Spauligodon gehyrae*, USNPC 93728).

#### DISCUSSION

*Paradistomoides gregarium* was originally described as *Paradistomum magnum* from specimens taken from the gall bladder of a gecko, *Hemidactylus frenatus*, collected in the Philippines by Tubangui (1928). However, *Paradistomum magnum* was preoccupied, and Tubangui (1929) changed the name to *Paradistomum gregarium*, which was assigned to its current genus by Travassos (1944). Synonyms include *Paradistomum brevis*, *P. geckorum*, *P. laruei*, *P. magnum*, *P. medicus*, *P. oroterminalis*, and *P. paloensis*. Additional hosts include the agamid lizards *Calotes versicolor*, *Hydrosaurus pustulatus*; the gekkonids *Cosymbotus platyurus*, *Gehyra mutilata*, *G. oceanica*, *Gekko* gecko, *Hemidactylus frenatus*, *H. brookii*, *Lepidodactylus guppyi*, *Nactus pelagicus*; the lacertid *Takydromus sexlineatus*; and the scincids *Emoia cyanurum*, *Lipinia noctua*, *Prasinohaema virens*, *Sphenomorphus solomonis* (Tubangui 1933, Fischthal and Kuntz 1967, Killick and Beverley-Burton 1982). *Emoia atrocostata* represents a new host record, and Belau is a new locality record.

*Hedruris hanleyae* was described from the stomach of a gecko, *Hemidactylus garnotii*, collected in the Cook Islands (Bursey and Goldberg 2000). Additional hosts include *Gehyra mutilata*, *G. oceanica*, *Hemidactylus frenatus*, *Lepidodactylus lugubris*, *L. moestus*, and *L. paurolepis*. *Emoia boettgeri*, *E. caeruleocauda*, *E. cyanogaster*, *E. cyanura*, *E. impar*, *E. nigra*, *E. nigromarginata*, *E. sanfordi*, and *E. trossula* represent new host records. Vanuatu and Federated States of Micronesia are new locality records.

*Maxvachonia chabaudi* was described from individuals pooled from nine species of lizards and one species of snake collected in Australia by Mawson (1972): the gekkonid *Phyllurus miliaris*; the scincids *Ctenotus australis*, *C. labillardieri*, *C. leae*, *Egernia whitii*, *Eulamprus kosciuskoii*, *Hemiergis peronii*, *Lerista bougainvillii*, *Morethia lineoocellata*; and the elapid *Pseudonaja affinis*. Additional Australian hosts include the scincids *Ctenotus brooksi*, *C. leonhardii*, *C. pantherinus*, *C. quattuordecimlineatus*, *C. regius*, and *Egernia inornata* and the varanid *Varanus tristis* (Jones 1988, Goldberg and

TABLE 1  
Prevalence as Percentage (P) and Mean Intensity  $\pm$  1 SD (M) for Each Helminth Species Infecting 11 Species of Skinks from Oceania

Emoia sp.	<i>Paradistomoides gregarium</i>		<i>Heduris hanleyae</i>		<i>Marcachonia chabaudi</i>		<i>Moaciria</i> sp.		<i>Parapharyngodon maplestoni</i>		<i>Physoboltoidea arnoensis</i>		<i>Spaludigadon gebryae</i>	
	P	M	P	M	P	M	P	M	P	M	P	M	P	M
<i>E. atrocostata</i>	1/1 (100)	22	—	—	—	—	—	—	—	—	—	—	—	—
<i>E. boettgeri</i>	—	—	1/1 (100)	1	—	—	—	—	1/1 (100)	1	—	—	—	—
<i>E. caeruleocauda</i>	—	—	8/8 (100)	2.3 $\pm$ 1.5	—	—	—	—	—	—	—	—	—	—
<i>E. cyanogaster</i>	—	—	2/2 (100)	1 $\pm$ 0	—	—	—	—	—	—	—	—	—	—
<i>E. cyanura</i>	—	—	5/9 (56)	6.6 $\pm$ 2.9	1/9 (11)	1	—	—	—	—	—	—	—	—
<i>E. impar</i>	—	—	5/5 (100)	1.8 $\pm$ 1.1	—	—	—	—	—	—	—	—	—	—
<i>E. nigra</i>	—	—	11/11 (100)	7.7 $\pm$ 3.7	3/11 (27)	7.0 $\pm$ 5.0	—	—	—	3/11 (27)	1.0 $\pm$ 0	5/11 (45)	3.2 $\pm$ 3.5	—
<i>E. nigromarginata</i>	—	—	10/10 (100)	2.7 $\pm$ 0.9	—	—	—	—	—	—	—	—	—	—
<i>E. ponapea</i>	—	—	—	—	—	—	—	—	1/1 (100)	6	—	—	—	—
<i>E. sanfordii</i>	—	—	1/1 (100)	1	—	—	—	—	—	—	—	—	—	—
<i>E. trosula</i>	—	—	3/4 (75)	8.0 $\pm$ 5.6	—	—	—	—	—	—	2/4 (50)	2.5 $\pm$ 2.1	1/4 (25)	3

Bursey 1995, 2000, Goldberg et al. 1999). Other reported hosts include *Emoia cyanura*, *Gehyra mutilata*, *G. oceanica*, *Lepidodactylus lugubris*, and *L. paurolepis* (Goldberg and Bursey 2002). *Emoia nigra* represents a new host record. The Kingdom of Tonga is a new locality record.

*Moaciria* is represented in Australia and Oceania by five species (Gibbons 1979, Jones 1979), four species described from snakes, namely *M. butleri*, *M. chondropythonis*, *M. et-nae*, *M. komodoensis*, and one species from a lizard, *M. sphenomorphi*. Species identification for *Moaciria* is based upon male caudal morphology. Only females were found in this study; thus identification to species was not attempted. *Emoia boettgeri* and *E. ponapea* represent new host records for *Moaciria*. Federated States of Micronesia is a new locality record.

*Parapharyngodon maplestoni* was originally described from the intestine of an agamid lizard, *Calotes versicolor*, collected in Burma by Chatterji (1933). Additional hosts include the agamid *Bronchocela cristatellus*; the anguid *Ophisaurus apodus*; the gekkonids *Hemidactylus flavoviridis*, *H. frenatus*; and the scincid *Glaucostrophus emigrans* (Goldberg and Bursey 2002). *Emoia nigra* is a new host record. The Kingdom of Tonga is a new locality record.

*Physalopteroides arnoensis* was described from the intestinal tract of the gecko *Lepidodactylus lugubris*, collected in the Republic of the Marshall Islands (Bursey and Goldberg 2001). Additional hosts include the gekkonids *Lepidodactylus moestus* and *L. paurolepis* (Goldberg and Bursey 2002). *Emoia nigra* and *Emoia trossula* represent new host records. The Kingdom of Tonga is a new locality record.

*Spauligodon gebryae* was described from the large intestine of the gecko *Gehyra oceanica*, collected in Guam (Bursey and Goldberg 1996). It has also been reported from *Lepidodactylus lugubris*. *Emoia trossula* represents a new host record. The Kingdom of Tonga is a new locality record.

Previous reports of helminths in species of *Emoia* include *Parapharyngodon kartana* (Pharyngodonidae) from *E. nigra* and *E. samoensis* and *Cylindrotaenia decidua* (Cestoda:

*Nematotaeniidae*), *Maxvachonia chabaudi*, and larvae of *Skrjabinoptera* sp. (Seuratidae) from *E. cyanura* (Goldberg and Bursey 1991, Goldberg et al. 2000). *Parapharyngodon kartana* was described from the scincid *Hemiergis peronii* by Johnston and Mawson (1941) and is also known from the agamid *Ctenophorus fionni*; the gekkonid *Christinus marmoratus*; and a scincid, *Lerista* sp. (Goldberg and Bursey 1991). *Cylindrotaenia decidua* was described from the scincid *Oligosoma nigriplantare* by Ainsworth (1985) and is also known from the scincid *Cryptoblepharus poecilopleurus* and the gekkonid *Gehyra oceanica* (Goldberg et al. 2000). Larvae of *Skrjabinoptera* were also reported from *Cryptoblepharus poecilopleurus* and *Lepidodactylus lugubris* (Goldberg et al. 2000).

The 10 species of helminths harbored by species of *Emoia* are generalists (species capable of infecting more than one species of lizard). For infection by these species, ecological factors related to egg survival may be more important than physiological (host) factors. Species of *Heduris*, *Moaciria*, *Parapharyngodon*, and *Spauligodon* have monoxenous life cycles and require the ingestion of an egg before infection can occur; species of *Physalopteroides* and *Skrjabinoptera* have heteroxenous life cycles that require the ingestion of the intermediate host; the life cycles of species of *Maxvachonia* are unknown, although other cosmocercoids produce larvae that utilize skin penetration as a route of infection (Anderson 2000). Trematodes and cestodes have heteroxenous life cycles (Roberts and Janovy 2005). Examination of ecological aspects of the natural history of species of *Emoia* may give a clue to the differential infection rates by the helminths reported here.

Helminthological examinations of additional species are required before the helminth diversity of lizard species from Oceania can be known and the distribution of helminths among the Pacific islands can be ascertained.

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### Literature Cited

- Ainsworth, R. 1985. *Baerietta decidua* n. sp. (Cestoda: Nematotaeniidae) from the New Zealand skink *Leiopisma nigriplantare macconnelli* Hardy, 1977. *N. Z. J. Zool.* 12:131–135.
- Anderson, R. C. 2000. Nematode parasites of vertebrates: Their development and transmission. 2nd ed. CABI Publishing, Wallingford, United Kingdom.
- Brown, W. C. 1991. Lizards of the genus *Emoia* (Scincidae) with observations on their evolution and biogeography. *Calif. Acad. Sci. Mem.* 15.
- Bursey, C. R., and S. R. Goldberg. 1996. *Spauligodon gebryae* n. sp. (Nematoda: Pharyngodidae) from *Gehyra oceanica* (Sauria: Gekkonidae) from Guam, Mariana Islands, Micronesia. *J. Parasitol.* 82:962–964.
- . 2000. *Hedruris hanleyae* n. sp. (Nematoda: Hedruridae) from *Hemidactylus garnotii* (Sauria: Gekkonidae) from the Cook Islands, Oceania. *J. Parasitol.* 86:556–559.
- . 2001. *Physalopteroidea arnoensis* n. sp. (Nematoda: Physalopteroidea) and other intestinal helminths of the mourning gecko, *Lepidodactylus lugubris* (Sauria: Gekkonidae), from Arno Atoll, Republic of the Marshall Islands, Oceania. *J. Parasitol.* 87:135–138.
- Chatterji, R. C. 1933. On a new nematode, *Parapharyngodon maplestoni* gen. nov., sp. nov., from a Burmese lizard. *Ann. Trop. Med. Parasitol.* 27:131–134.
- Fischthal, J. H., and R. E. Kuntz. 1967. Digestive trematodes of amphibians and reptiles from Fiji, New Hebrides and British Solomon Islands. *Proc. Helminthol. Soc. Wash.* 34:244–251.
- Gibbons, L. M. 1979. *Moaciria chondropythonis* sp. n. (Heterakidae; Spinicaudinae), a nematode from a Papuan tree python, *Chondropython viridis*. *J. Helminthol.* 53:301–306.
- Goldberg, S. R., and C. R. Bursey. 1991. *Parapharyngodon kartana* in two skinks, *Emoia nigra* and *Emoia samoense* (Sauria: Scincidae), from Samoa. *J. Helminthol. Soc. Wash.* 58:265–266.
- . 1995. Gastrointestinal nematodes of two Australian skinks, *Ctenotus regius* and *Ctenotus schomburgkii* (Sauria: Scincidae). *J. Helminthol. Soc. Wash.* 62:237–238.
- . 2000. Intestinal helminths of five species of scincid lizards (Sauria: Scincidae) from Western Australia. *Trans. R. Soc. S. Aust.* 124:127–133.
- . 2002. Gastrointestinal helminths of seven gekkonid lizard species (Sauria: Gekkonidae) from Oceania. *J. Nat. Hist.* 36:2249–2264.
- Goldberg, S. R., C. R. Bursey, and H. Cheam. 1998. Gastrointestinal helminths of four gekkonid lizards, *Gehyra mutilata*, *Gehyra oceanica*, *Hemidactylus frenatus* and *Lepidodactylus lugubris* from the Mariana Islands, Micronesia. *J. Parasitol.* 84:1295–1298.
- . 2000. Gastrointestinal helminths of four lizard species from Moorea, French Polynesia. *Comp. Parasitol.* 67:118–121.
- Goldberg, S. R., C. R. Bursey, and S. Hernandez. 1999. Nematodes of two skinks, *Ctenotus leonhardii* and *Ctenotus quattuordecimlineatus* (Sauria: Scincidae), from Western Australia. *J. Helminthol. Soc. Wash.* 66:89–92.
- Johnston, T. H., and P. M. Mawson. 1941. Some nematodes from Kangaroo Island, South Australia. *Rec. S. Aust. Mus. (Adelaide)* 7:145–148.
- Jones, H. I. 1979. New species of *Moaciria* Freitas 1956 (Nematoda: Heterakoidea) from Australian reptiles. *J. Helminthol.* 53:133–140.
- . 1988. Nematodes from nine species of *Varanus* (Reptilia) from tropical northern Australia with particular reference to the genus *Abbreviata* (Physalopteridae). *Aust. J. Zool.* 36:691–708.
- Killick, L. M., and M. Beverley-Burton. 1982. Observations on digenleans from lizards (Sauria) in Indonesia (*Paradistomum geckorum*, *Mesocoelium sociale*, and *Postorchigenes ovatus*) with a revision of *Paradistomum* Kossack, 1910 (Dicrocoeliidae). *Can. J. Zool.* 60:2093–2106.

- Mawson, P. M. 1972. The nematode genus *Maxvachonia* (Oxyurata: Cosmocercidae) in Australian reptiles and frogs. Trans. R. Soc. S. Aust. 96:101–108.
- Roberts, L. S. and J. Janovy Jr. 2005. Gerald D. Schmidt & Larry S. Roberts' Foundations of Parasitology. 7th ed. McGraw Hill, Boston.
- Travassos, L. 1944. Revisão da família Dicrocoeliidae Odhner, 1910. Monogr. Inst. Oswaldo Cruz Rio de J. 2.
- Tubangui, M. A. 1928. Trematode parasites of Philippine vertebrates. Philipp. J. Sci. 36:351–371.
- \_\_\_\_\_. 1929. *Paradistomum gregarium*, a new name for the trematode *Paradistomum magnum*. Philipp. J. Sci. 38:443.
- \_\_\_\_\_. 1933. Trematode parasites of Philippine vertebrates, VI: Descriptions of new species and classification. Philipp. J. Sci. 52:167–197.